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THIRD MONTHLY PROGRESS REPORT

CONTRACT NAS 2-3460

This report summarizes the work accomplished under NASA Contract NAS 2-3460 during the time period from August 1 to August 31, 1963. The effort was concentrated in three basic areas: the continued assembly of the various numerical solutions to the fluid dynamic problems, the programming of these solutions by the Math Analysis group and the checkout of the programs on the computer.

During the month of August, the routines for shock intersection and vortex sheet computation for an ideal gas were assembled and given to the Math Analysis group. The real gas solution for the above was initiated along with the routines for shock boundary layer interactions (separation) shock-vortex intersection and transition. It is now estimated that the routines will be completed and forwarded to Math Analysis by September 20. In addition, work is continuing on the modification of the discontinuity analogy turbulent boundary layer solution to account for real gas effects and heat transfer. This program is also being modified to allow the computation of the dimensional quantities, such as the boundary layer thickness δ , displacement thickness δ^* , and momentum thickness θ . This is being done by breaking the integral momentum equation up into small zero pressure gradient and discontinuous elements, consistent with the D/A theory, and solving the resulting differential equations by numerical methods for the momentum thickness.

The Mathematical Analysis Department has completed programming of the external isentropic compression surface routine and the laminar boundary layer routine. This latter routine is based primarily on the methods developed in references 1 and 2. It is expected that programming of the shock intersection solution along with the combined viscous-inviscid solution for the laminar case will begin shortly (i.e., the body pt. routine will be modified for the laminar boundary layer case). The two turbulent boundary layer solutions are continuing to be carried along such that it will be possible to utilize either one in the complete inlet program.

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Program checkout was begun in August for the various Method of Characteristics routines. The test case currently being examined is a blunted cone with a sharp cowl lip at Mach 10. The field, shock and body point routines have been checked out completely; however, problems have occurred with the mesh cutting routine; i.e., the routine that reduces the characteristic field mesh size when it exceeds a given limit or fails to converge in a given number of iterations. These difficulties are expected to be resolved in the very near future.

Results continue to be obtained from the two turbulent boundary layer solutions, references 3 and 4. Data from reference 5 have been compared with both of these boundary layer solutions. As seen from figure 1 these theories agree reasonably well. As one part of this investigation, several step sizes were used in the D/A method to determine if the solution is sensitive to interval size. Two different step sizes, 8 and 40, were examined for both maximum and minimum cooling cases. Figure 1 shows these solutions indicating little effect of step size on the form factor H.

No major problems have been encountered to date. It has taken somewhat longer than expected to assemble all of the numerical techniques; however, program checkout is proceeding ahead of schedule.

John L. Benson
Program Technical Director

REFERENCES

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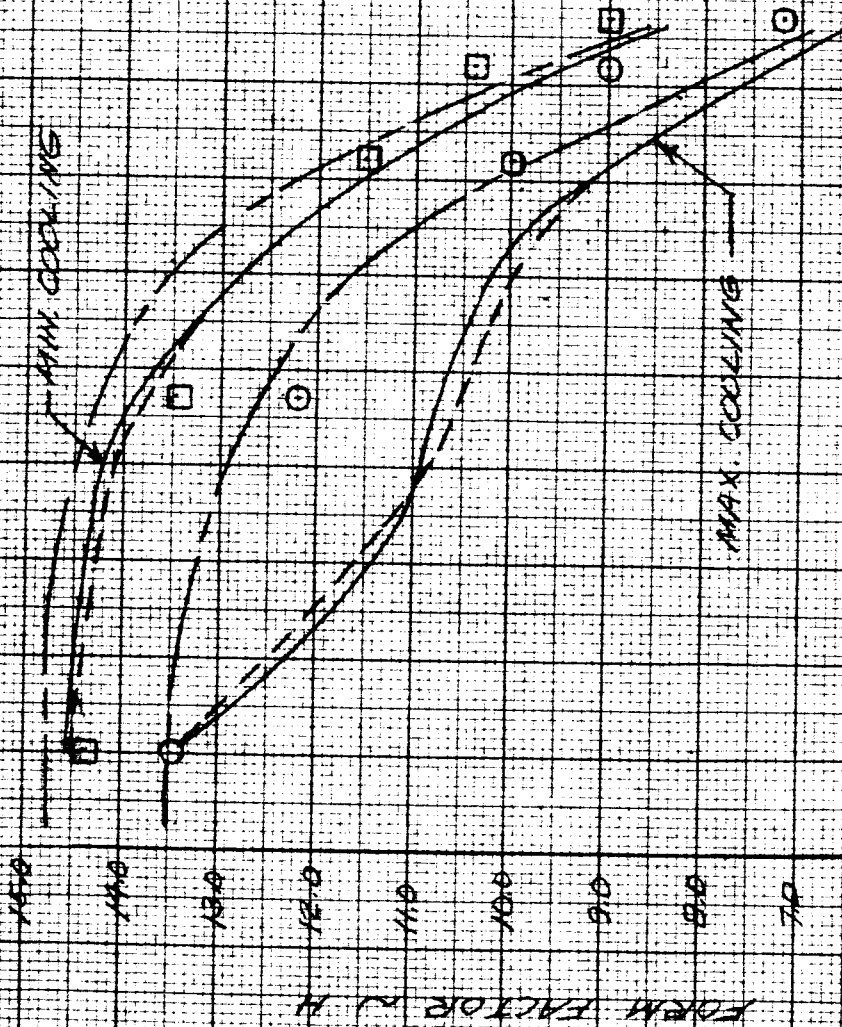
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